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Correlation between active command disorder and ambulation speed in chronic spastic paresis

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Introduction In spastic paresis, the ambulation impairments are mainly associated with the paresis of agonists and the contracture/cocontraction/spasticity of antagonists [1]. The objective is to explore correlation between these neuromuscular mechanisms associated with the deficits of hip, knee and ankle flexion in swing phase and the ambulation speed.
Methods Twenty-one chronic hemiparetic subjects (time since stroke, 8 ± 8years) performed a barefoot 10-meter ambulation test at comfortable (SPcomf) then maximal (SPmax) speed [2] and an evaluation of the antagonist resistance [3] due to 4 main muscles: soleus, gastronemius, gluteus maximus and rectus femoris. The parameters quantified were: speed ambulation, and for each muscle, the passive range of motion (maximal slow stretch, X_{V1}), the angle of catch at fast stretch (X_{V3}), the active range of motion (A), the frequency of active alternative fast movements in 15s (F_{15}) and the range of the last active movement in 15s (A_{15}). A multivariate correlation analysis was performed between the X_{V1}, X_{V3}, A, F_{15} and A_{15} parameters and ambulation speeds.
Results Comfortable speed 0.61 ± 0.25 m/s, fast 0.71 ± 0.29 m/s. In distal, ambulation speed was positively correlated with A_{Soleus} (vs SPcomf, $r = 0.54$, $P = 0.011$; SPmax, $r = 0.47$, $P = 0.032$), $F_{15\text{-}Soleus}$ (vs SPcomf, $r = 0.67$, $P = 0.001$; SPmax, $r = 0.71$, $P < 0.0001$) and $F_{15\text{-}Gastrocnemius}$ (vs SPcomf, $r = 0.48$, $P = 0.028$; SPmax, $r = 0.40$, $P = 0.071$). In proximal, ambulation speed was positively correlated with $A_{15\text{-}GluteusMaximus}$ (vs SPcomf, $r = 0.46$, $P = 0.036$; SPmax, $r = 0.43$, $P = 0.052$), and $X_{v1\text{-}RectusFemoris}$ (vs SPcomf, $r = 0.44$, $P = 0.051$; SPmax, r = *0.41*, P = *0.070*).
Conclusions In chronic spastic paresis, the decrease of ambulation speed is correlated with the deficit of ankle dorsiflexion active command associated with the tibialis anterior paresis/triceps surae cocontraction, and with the deficit of the hip flexion active command associated with the hip flexors paresis/gluteus maximus cocontraction and the rectus femoris contracture.
Keywords Speed ambulation; Paresis; Cocontraction; Active command; Spasticity
Disclosure of interest The authors have not supplied their declaration of conflict of interest.
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Functional electrical stimulation during post stroke walk: Latest developments

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After stroke some residual gait deficits can remain and are prevalent. Foot drop is one of the common impairment which affects around 20% of stroke survivors. This impairment is caused by a paresis (total or partial) of the muscles involved in ankle dorsiflexion. This muscle weakness makes the ground clearance problematic during the swing phase of gait. This default can be compensated by ankle foot orthosis (AFO) but also by functional electrical stimulation. This is an ancient technique that has benefited from recent advances in technology: wireless link, implanted stimulation, replacement of the heel switch by an inclinometer (System Walkaid)... The SEF is effective in improving walking parameters including walk speed but despite these recent technological improvements, it does not show that it is a more effective device than ankle foot orthoses in a recent study [1]. An inertial node combining an accelerometer, a gyroscope and a magnetometer placed on one of the two legs, is used to estimate the continuous walking cycle [2]. This can advantageously replace the switch in the heel to improve reliability to determine when to start or end the stimulation and also allow for example to start the stimulation at any time, including before the heel off the ground. Moreover, this inertial node should also estimate a number of walking parameters including the quality of ankle dorsiflexion and walking type (normal walk but also pass an obstacle, turn around or climbing stairs) and thus to propose an adaptive functional electrical stimulation in an intelligent way. The purpose of the presentation is to provide an update on the latest clinical studies and develop perspectives brought by the use of inertial nodes coupled with a wireless stimulator to integrate decision algorithms.
Keywords Functional electrical stimulation; Stroke; Walk
Disclosure of interest The authors have not supplied their declaration of conflict of interest.
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Spastic co-contraction of gastrocnemius medialis and peroneus longus during swing phase of gait in hemiplegic children

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Introduction Spastic cocontraction [1] is a form of muscle overactivity [1,2] that may alter gait in infant hemiparesis. We quantified EMG activity in Gastrocnemius Medialis (GM) and Peroneus Longus (PL) during the swing phase (SW) of gait in very young hemiparetic children with an equino-valgus pattern [3], comparing the paretic and non-paretic side.

Materials and methods Ten hemiparetic children (age 3 ± 1, mean $\pm$ SD) were monitored for GM and PL EMG during gait. The SW was divided into three thirds (initial-T1, middle-T2 and end-T3). In each period, a Cocontraction Index (CCI) [4], ratio of the Root Mean Square (RMS) EMG from each muscle during that period to the peak 500-ms RMS obtained from voluntary plantar flexion during a selected submaximal state (standing on tiptoes) was measured.

Results GM and PL CCIs during SW were higher on the paretic than on the non-paretic side (Wilcoxon:CCI_{GM}, $P < 0.01$;CCI_{PL}, $P < 0.01$). When subdividing the SW, there was a CCI increase on the paretic side during mid and late SW for GM (Wilcoxon: CCI_{GMT2}, $P < 0.01$;CCI_{GMT3}, $P < 0.001$), and during early, mid and late SW for PL (Wilcoxon: CCI_{PLT1}, $P = 0.03$;CCI_{PLT2}, $P = 0.014$ and CCI_{PLT3}, $P < 0.001$).

Discussion and conclusion GM and PL cocontraction increases may contribute to the equinus on the paretic side. Specifically, PL cocontraction increase might cause the hind-foot valgus at late swing, moving the first metatarsal downwards and pronating the forefoot. Quantification of cocontraction could provide a better understanding of the adverse muscle actions and contribute to better target the therapeutic actions, especially botulinum toxin injection in PL, to improve gait in very young hemiparetic children before orthopaedic deformation.

Keywords Cerebral palsy; Spastic co-contraction; Equinus; Gastrocnemius medialis; Peroneus longus; EMG

Disclosure of interest The authors have not supplied their declaration of conflict of interest.

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Locomotor independence level assessment of stroke survivors using an obstacle course: Development and validation

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Objective Traditional gait assessments often evaluate patients in idealised conditions (level ground, straight way, no obstacle) in order to define the gait capacity. In this sense, the way the patient walks in daily gait conditions remains unknown and the level of locomotor independence cannot be evaluated. The aim of this study was thus to develop and validate a course with ecological gait conditions. This tool must be able to categorise patients by their capacity to cross a set of obstacles linked to three level of independence: limited household walkers, limited community walkers and community walkers [1].

Material/patients The gait obstacle course is composed of four 10-m walking tests (t1 to t4) and one 6-min walking test. The tests t1 and {t2, t3, t4} respectively represent the traditional 10-m walk test and a set of 10-m walk tests with obstacles corresponding to the 3 evaluated levels of independence. 14 stroke survivors patients (50 ± 15 years old) were selected and gave their consent. This study was validated by the local ethic committee of CNRFR, Rehazenter.

Method The time to perform each part of the course was evaluated for all the patients 3 times by 2 operators in a randomised order. In order to realise a first validation of the course, inter- and intra-operator tests were then performed based on these records. A Wilcoxon test was employed for that with a confidence level of 95%.

Results On the whole, patients having a similar functional level present difficulties at the same part of the gait obstacle course. Moreover, tests {t2, t3, t4} and {t1, t2, t4, 6 min} present a significant reproducibility inter- and intra-operator.

Discussion Results are encouraging and demonstrate the potential of the proposed gait obstacle course. However, this first validation must be completed by evaluating much more patients and by achieving additional tests such as sensitivity tests before a daily clinical use.

Keywords Gait course; Independance level; Ecological conditions; Stroke

Disclosure of interest The authors have not supplied their declaration of conflict of interest.

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Long-term effects of an implantable peroneal nerve stimulator on kinematics and gait capacities in the drop-foot treatment of stroke survivors

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Objective The aim of this study was to show the long-term effects of an implantable peroneal nerve stimulator on articular kinematics and gait capacities in the drop-foot treatment of stroke survivors.

Material and method Twelve patients (4 women, 8 men, 45.45 ± 12.88 years, 171.92 ± 8.07 cm, 81.14 ± 20.30 kg) were selected and implanted with a Actigait stimulator (Neurodan, Denmark, OttoBock Group) in the CHL hospital of Luxembourg. A 12-month follow-up was proposed in CNRFR, Rehazenter to these patients composed of 4 assessments (1 month before implantation and 3, 6 and 12 months after implantation). At each assessment, a 10-m walk test, a 6-min walk test, a four-square step test and a clinical gait analysis were performed. A t-test was used to evaluate the improvement of each parameter with confidence level of 95%.

Results Most of the followed parameters, such as gait symmetry, foot/ankle kinematics and balance, are significantly improved after implantation. However, the 10-m walk test does not show any significant gait velocity improvement. Similarly, no significant effect appears on the compensations developed during gait. Even if the stimulator mainly has an orthotic effect, a therapeutic effect is shown for this patient group on the foot prepositioning in dorsiflexion at foot strike.

Discussion Unlike recent results reported in the literature [1], gait velocity does not seem to be impacted by the use of the stimulator during gait. However, the global quality of gait is improved, with a better gait symmetry, a reduced risk of falling and